DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

FOLIO OF THE
GOODNEWS AND HAGEMEISTER ISLAND QUADRANGLES REGION
OPEN FILE REPORT 78-9-B
HOARE AND COONRAD -- GEOLOGY
SHEET 2 OF 2

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS

Qa	Holocene	QUATERNARY
Qg	Holocene and Pleistocene	QUATERNARY

VOLCANIC AND SEDIMENTARY ROCKS

Qtb	Pleistocene	QUATERNARY
QTs	Pleistocene or Pliocene	QUATERNARY or TERTIARY
Tv	Lower Tertiary	TERTIARY
Ks	Upper Cretaceous (Maestrichian ?)	CRETACEOUS
Kk	Upper and Lower Cretaceous	CRETACEOUS
Kb Klg Kts Kcg	Lower Cretaceous	CRETACEOUS
KJvs	Lower Cretaceous to Middle Jurassic	CRETACEOUS AND JURASSIC
Jk Jvs	Middle to Lower Upper Jurassic	JURASSIC
Jlvs	Lower Jurassic	JURASSIC
Rvs, Pv, MzPz, Pl, DOl	Lower Cretaceous to Lower (?) Ordovician	CRETACEOUS TO ORDOVICIAN

INTRUSIVE ROCKS

Tif Tim Tn	TERTIARY
TKg	TERTIARY AND CRETACEOUS
Jg Jum Jt	JURASSIC AND JURASSIC (?)

METAMORPHIC ROCKS

Pzcs	PALEOZOIC
Pzmg	PALEOZOIC (?)
pCl pCk	PRECAMBRIAN

POTASSIUM-ARGON AGE DETERMINATIONS

Table 1.--Potassium-argon ages, Goodnews and Hagemeister Island quadrangles region, southwestern Alaska

[Argon measurements were made by J. G. Smith and F. H. Wilson using standard isotope dilution techniques. Potassium measurements by J. H. Christie, Marcelyn Cramer, and F. H. Tillman were done by flame photometry using a lithium internal standard. Ages were calculated using year 1976 constants as follows: K^{40} decay constants--$\lambda\varepsilon=0.572X10^{-10}yr^{-1}$, $\lambda e'=8.78X10^{-10}yr^{-1}$, $\lambda\beta=4.963X10^{-10}yr^{-1}$; abundance ratio--$K^{40}/K=1.167X10^{-4}mol/mol$.]

Map symbol (field number)	Location quadrangle latitude and longitude	Age in million years plus or minus analytical uncertainty	Material dated	Rock type (unit and form)	Percent K_2O (average)	$^{40}Ar_{rad}$ (moles/gm $X10^{-10}$)	$^{40}Ar_{rad}$ (percent)	Dated by	Name References
A (74AHR 77)	Goodnews B-3 59°17'51"N, 159°58'10"W.	0.778±0.2	Whole rock	Basalt (Qtb-flow)	1.097	1.23	44	J. G. Smith	Basalt of Togiak River Valley
B (74AHR 26)	Hagemeister Island D-1 58°57'00"N, 160°00'35"W.	13.0±0.5	Biotite	Biotite felsite (Tif-sill)	8.45	1.590	77	----do-----	Nunavachak Hills Wilson, 1977, #35
C (GC4 1300)	Goodnews C-4 59°37'05"N, 160°08'30"W.	60.7±1.8	Hornblende	Hornblende granite (Tn-intrusive-extrusive complex)	.871	.7744	67	F. H. Wilson	Nayorurun Wilson and Smith, 1976; Wilson, 1977, #2
D (74ACD 14D)	Nushagak Bay D-6 58°51'05"N, 159°58'40"W.	64.6±2	Biotite	Biotite diabase (Tim-dike)	7.635	7.215	79	J. G. Smith	
E (GB1 3156)	Goodnews B-1 59°27'55"N, 159°10'35"W.	69.5±2.1 63.4±1.9	Biotite Hornblende	Quartz diorite (TKg-stock)	6.82 .4115	6.953 .3823	88 39	F. H. Wilson	Zone Creek Wilson and Smith, 1976; Wilson, 1977, #11
F (74B 57)	Goodnews C-1 59°37'35"N, 159°00'00"W.	69.6±2.1 63.4±1.9	Biotite Hornblende	Granodiorite (TKg-stock)	8.765 .639	8.953 .5934	88 27	J. G. Smith	Akuluktuk Wilson and Smith, 1976; Wilson, 1977, #5
G (GD1 3154)	Goodnews D-1 59°50'35"N, 159°10'55"W.	62.5±1.9 65.2±2.0	Biotite Amphibole-pyroxene	Granodiorite (TKg-stock)	8.135 .5065	7.445 .4842	89 43	F. H. Wilson	Mt. Waskey Wilson and Smith, 1976; Wilson, 1977, #9
H (GA5 1310)	Goodnews A-5 59°10'17"N, 160°38'55"W.	67.4±2.0	Biotite	Tonalite (TKg-stock)	8.285	8.180	81	----do-----	Sulutak Wilson and Smith, 1976; Wilson, 1977, #13
I (GD5 1771)	Goodnews D-5 59°51'08"N, 160°48'51"W.	68.7±3	Hornblende	Hornblende dacite (TKg-stock)	.6495	.6546	51	----do-----	Sam Creek
J (74AHR 118)	Goodnews C-2 59°39'37"N, 159°40'20"W.	63.7±2.0 69.5±3	Biotite Hornblende	Quartz monzonite (TKg-stock)	9.275 .575	8.647 .5865	80 66	J. G. Smith	Togiak Lake Wilson and Smith, 1976; Wilson, 1977, #6
K (73AHR 1)	Goodnews D-3 59°55'06"N, 159°54'55"W.	71.1±2.1	Biotite	Quartz monzodiorite (TKg-stock)	9.32	9.713	92	----do-----	Mt. Oratia Wilson and Smith, 1976; Wilson, 1977, #8
L (GB7 1479A)	Goodnews B-7 59°20'45"N, 161°19'30"W.	71.3±2.1	Biotite	Quartz diorite (TKg-stock)	9.045	9.459	87	F. H. Wilson	Wattamuse Wilson and Smith, 1976; Wilson, 1977, #12
M (74AHR 51)	Nushagak Bay D-5 59°53'45"N, 159°28'52"W.	71.9±2	Biotite	Pyroxene monzonite (TKg-stock)	9.405	9.925	92	J. G. Smith	Kulukak Wilson, 1977, #23
N (GC1 1381)	Goodnews C-1 59°39'55"N, 159°20'35"W.	72.5±2.2	Biotite	Tonalite (TKg-stock)	7.88	8.389	80	F. H. Wilson	Sunday Creek Wilson and Smith, 1976; Wilson, 1977, #7
O (GA7 1450)	Goodnews A-7 59°01'17"N, 161°31'25"W.	162.4±4.9	Amphibole	Diorite (Jg-stock)	1.174	2.871	92	----do-----	Crater Hill Wilson and Smith, 1976; Wilson, 1977, #28
P (74AHR 112)	Hagemeister Island D-3 58°59'13"N, 160°58'08"W.	159.3±3.5 (minimum age)	Hornblende	Gabbro (Jg-stock)	0.7705	1.847	72	----do-----	Matogak Wilson, 1977, #31
Q (74AHR 111)	Hagemeister Island D-4 58°57'52"N, 161°03'00"W.	186.9±6	Hornblende	Gabbro (Jg-stock)	1.11	3.071	92	J. G. Smith	Downdraft Mountain Wilson, 1977, #32
R (HD6 2272A)	Hagemeister Island D-6 58°54'46"N 161°46'20"W.	176.4±5.3	Amphibole	Amphibolite (Jum-Red Mtn. contact zone)	.230	.6137	41	F. H. Wilson	
S (HD6 1453E)	Hagemeister Island D-6 58°55'06"N, 161°46'28"W.	186.9±5.6	Amphibole	-------do-------	.5205	1.475	79	----do-----	

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qa ALLUVIAL DEPOSITS--Includes flood-plain alluvium, beach and estuarine deposits, and dunes. Flood-plain alluvium consists of sand, gravel, and boulders intertonguing with mud and overlain by silt near the seacoast. Beach deposits, chiefly sand and small pebbles, include boulders near sea cliffs. Estuarine deposits are clay-rich silt deposited by tidal currents in lower reaches of sluggish rivers. Dune deposits of fine-grained sand fringe landward sides of sandy beaches

Qg GLACIAL DEPOSITS--Glacial drift deposited during at least three glacial advances. Includes end, lateral, and ground moraines and fluvioglacial deposits. Locally includes colluvium, talus, landslide debris, alluvium on minor streams, and extensive deposits of silt in the northwestern part of the mapped area. Consists of sand, gravel, and boulders intertonguing with and overlain by silt near the seacoast. Muller (1953, p. 3) notes evidence of at least three major glaciations in the "eastern Kilbuck Mountains." (The mountains referred to by Muller are the Wood River Mountains at the east edge of the area included in this report.) Approximate positions of many prominent moraines are shown on the earlier maps by Hoare and Coonrad (1959a, 1961a, 1961b). Porter (1967) identifies and describes the glacial deposits in the Chagvan Bay-Goodnews Bay area. Chiefly Wisconsinan age, but includes post-Wisconsinan deposits in upper parts of some valleys and may include older pre-Wisconsinan drift in places near the seacoast

VOLCANIC AND SEDIMENTARY ROCKS

Qtb BASALT OF TOGIAK RIVER VALLEY--Fine- and medium-grained, columnar-jointed tholeiite and alkali-olivine basalt flows on the broad floor of Togiak Valley, and rocks forming a tuya (Hoare and Coonrad, 1978) near Togiak village are grouped together as basalt of Togiak River valley. Flows generally have diktytaxitic texture and contain vesicle cyclinders (Goff, 1976). Average thickness probably less than 20 m near the seacoast but about 100 m north of Pungokepuk River. K/Ar age of one flow is 0.778 + 0.2 m.y. (table 1, locality A). Tuya consists of 30 to 50 m of glassy subaerial flows overlying palagonitized basaltic glass (sideromelane) and subaqueous pillow basalts

QTs SEMICONSOLIDATED MARINE BEACH DEPOSITS--Poorly bedded, soft, pebbly siltstones cap volcanic rock sea cliffs east side Hagemeister Island. Probable uplifted beach deposit, now 15 to 20 m above sea level. Contains shallow marine fossils of probable Plio-Pleistocene age (W. O. Addicott, written commun., 1975). Thickness 15 to 30 m

Tv VOLCANIC ROCKS AND VOLCANOGENIC DEPOSITS--Mostly andesitic and trachytic tuffs, breccias, and flows. Includes lesser amounts of basaltic andesite and diabase and fine- to medium-grained volcanogenic sediments. Crops out on Hagemeister Island, the Walrus Islands, the mainland coast nearby, and the northwest of Great Ridge. Mostly gently dipping except on High Island where beds are near vertical and on the east side of Hagemeister Island where the rocks are folded. If not duplicated by folds or faults, the rocks exposed on High Island are about 2,500 m thick. They are much thinner on the nearby mainland and are locally only a few meters thick. Tertiary age inferred because the volcanic rocks overlie the sedimentary rocks of Summit Island (Ks) of Late Cretaceous age. In places the graywacke of Kulukak Bay (Jk) of Jurassic age is thrust on top of this volcanic unit

Ks SEDIMENTARY ROCKS OF SUMMIT ISLAND--A sequence of intertonguing nonmarine conglomerate, sandstone, shale, and carbonaceous mudstone containing abundant plant detritus and a few coal seams forms the north end of Summit Island and underlies most of the south end where it is capped by volcanic rocks (Tv). Similar rocks crop out on Hagemeister Island and on the mainland northeast of Summit Island where they extend inland up the valley of the Ungalikthluk River. The sequence is overlain by younger volcanic rocks (Tv) at several places and is generally faulted against older rocks. The thickest known section is on the north end of Summit Island where about 250 m of pebble-cobble conglomerate is overlain by about 550 m of sandstone, siltstone, and carbonaceous mudstone and lesser amounts of conglomerate. However, the base of the section is truncated by a reverse fault, and the top is covered by water north of the island. On Hagemeister Island and on the mainland, the sequence includes a thick section of soft black shales which probably overlie the section on Summit Island. Conglomerate clasts consist of well-rounded fragments of volcanic and sedimentary rocks, white quartz, and a few plutonic clasts. Palynomorphs found in carbonaceous mudstones on the Ungalikthluk River (sec. 15, T. 15 S., R. 65 W.) indicate a Late Cretaceous (Maestrichtain?) age (R. H. Tschudy, written commun., 1975; Hoare and others, 1975, p. 7-8)

Kk KUSKOKWIM GROUP (Cady and others, 1955, p. 35-47)--A thick dominantly marine sedimentary unit consisting of graywacke, sandstone, conglomerate, siltstone, and shale forms Great Ridge and flanks the northwest and southeast sides of the Eek Mountains. It also crops out in small erosion windows, two of which are on the south flank of the belt of metamorphic rocks (pCk) in T. 6 and 7 S., R. 70 W. and a third in T. 6 S., R. 66 W. In the first two windows, micaceous shale and shaly siltstones dip gently southward and are overlain by volcanic rocks of upper Paleozoic age (MzPz). Graded bedding shows the shales are overturned. In the third window, micaceous shales and conglomerate containing gneissic clasts are exposed

The stratigraphic sequence is conglomerate, overlain by micaceous shales and siltstones which are overlain by a thick section of interbedded graywacke, siltstone, and shale. The conglomerate has a maximum thickness of about 1,500 m on the north flank of the Eek Mountains (T. 1 S., R. 64 W.). From this area it grades laterally into and intertongues southeastward with a much thicker section of interbedded graywacke, shale, and minor conglomerate which forms the southeast flank of the Eek Mountains and the high rounded hills on either side of the upper Kwethluk River. The conglomerate is characterized by well-rounded clasts of gneissic rocks that come from metamorphic rocks of the Kanektok River region (pCk). The fine-grained rocks contain detrital mica from similar source rocks

An upper Early Cretaceous (Albian) age is inferred for the conglomerate on the basis of stratigraphic position and fossils found north of the map area (Hoare and Coonrad, 1959a, and unpublished field notes)

Great Ridge is formed by a thick, moderately folded section of interbedded graywacke, siltstone, shale, and minor pebble conglomerate containing fossils of Late Cretaceous (Cenomanian and Turonian) age (D. L. Jones, written commun., 1977). Most of the rocks are marine, but near Eek River the section contains abundant plant material, one or two thin coal beds, and impure pebbly limestone containing fossil gastropods. These rocks may be nonmarine. The rocks on Great Ridge contain relatively little detrital mica, and thin conglomerate beds are composed chiefly of round white quartz pebbles

Structural complexity, abrupt facies changes, and widespread surficial deposits preclude accurate thickness estimates, but the entire unit is probably at least 4,000 m thick and may be much thicker

Kb GRAYWACKE OF BUCHIA RIDGE--A thick unit of marine sedimentary rocks of Early Cretaceous age underlies a triangular area defined by three southeast-dipping reverse faults in the southeast quarter of the Goodnews quadrangle (Hoare and others, 1975, p. 3-4). It forms Buchia Ridge and underlies the Kulukak Valley east of the ridge. Buchia Ridge consists of 1,500 to 2,000 m of east-dipping interbedded calcareous graywacke, siltstone, and conglomerate. Conglomerate becomes coarser and more abundant upward, and near the top of the ridge it contains local Buchia shell coquinas as thick as 1.2 m. Conglomerate clasts are well rounded. They are chiefly fragments of hard, fine-grained sedimentary rocks, tuffs, porphyritic volcanic rocks, and some white quartz. Most of the clasts are derived from nearby rocks of Jurassic and Early Cretaceous ages (Jk, KJvs). Poorly exposed rocks beneath Kulukak Valley dip consistently eastward and consist of calcareous siltstone, shale, calcarenite, and some graywacke. Fossils obtained from the unit show that it is Early Cretaceous in age and includes strata of both Valanginian and Hauterivian ages (D. L. Jones, written commun., 1975; Hoare and others, 1975). The thickness is estimated to be 3,000 m, but sequence is truncated top and bottom by thrust faults, and it probably is more than 3,000 m thick

Klg LIMY GRIT AND LIMESTONE--A thin, highly restricted unit coeval with the conglomeratic rocks in the graywacke of Buchia Ridge (Kb) constitutes five isolated exposures that are alined northeastward 2 to 5 km west of Buchia Ridge (Hoare and others, 1975, map and p. 4-5). The unit consists chiefly of small, green, fine-grained angular rock fragments and minor round quartz pebbles cemented by gray bioclastic limestone consisting of tiny shell fragments. Rock fragments are chiefly quartz-chlorite, sericite schist. Some beds are mostly limestone, others mostly lithic clasts. The metamorphic clasts are derived from parts of the adjacent and underlying volcanic and sedimentary rocks (KJvs), which are locally tectonically metamorphosed along faults. Contains Buchia of Early Cretaceous (Valanginian) age (Hoare and others, 1975). Measured thickness at one locality, 175 m. Overlain by about 140 m of thick-bedded, noncalcareous graywacke which also contains schist clasts

Kts TUFFS AND SEDIMENTARY ROCKS--A thick highly varied assemblage of andesitic tuffs, sedimentary rocks, and a few flows. Underlie a broad belt that extends from south of the upper Goodnews River northeastward to and beyond the north edge of the geologic map. Also on Hagemeister Island. Tuffs are mostly fine-grained green or gray rock but locally red. Tuffs and tuffaceous sediments commonly laumontitized and have a mottled or speckled appearance. Most distinctive rock in the assemblage is massive crystal-lithic tuff made up largely of broken plagioclase crystals (oligoclase-andesine) and angular green and black fragments of fine-grained tuff and tuffaceous chert. Lithic fragments range in size from microscopic to 30 cm. Sedimentary rocks are chiefly hard, massive, or medium-bedded graywacke and siltstone and lesser amounts of calcareous pebble conglomerate and impure limestone. Buchia of Early Cretaceous (Valanginian) age occur in some of the calcareous rocks. Radiolaria of Early Cretaceous age (E. A. Pessagno, written commun., 1977) occur in some of the tuffaceous cherts. Thickness unknown but probably 5,000 to 10,000 m

Kcg GRAYWACKE AND CONGLOMERATE--A marine sedimentary unit consisting of hard graywacke, shaly and blocky siltstones, and local conglomerate. Rocks commonly calcareous, contain Buchia of Early Cretaceous (Valanginian) age. Thickness unknown, probably 1,000 to 2,000 m

KJvs VOLCANIC AND SEDIMENTARY ROCKS--A thick, widespread marine unit consisting largely of volcanic and sedimentary rocks ranging in age from Middle Jurassic to Early Cretaceous. May include a few older rocks of Triassic and Permian ages. The volcanic rocks range in composition from mafic pillow basalts to more abundant andesitic and trachytic flows, tuffs, and breccias. Interbedded with the volcanic rocks are thick sections of tuffaceous siltstone, tuffaceous cherts, and massive or thin-bedded argillite. Tuffs and tuffaceous sedimentary rocks associated with the intermediate composition volcanic rocks are commonly laumontitized. The laumontitized rocks are mottled or speckled light green, gray, or brownish rocks. Hard blocky graywacke containing black argillite chips mapped in this unit in the northeast corner of the map area is probably coeval with the graywacke of Kulukak Bay (Jk). Most volcanic rocks are probably of intermediate composition, but the unit also contains pillow basalts which are most abundant between the lower Togiak and Osviak Rivers. Age based upon Radiolaria of late Late Jurassic to early Early Cretaceous age (E. A. Pessagno, written commun., 1977) and fragmentary ammonites of Middle Jurassic age (R. W. Imlay, written commun., 1976)

Jk GRAYWACKE OF KULUKAK BAY--A thick marine sedimentary unit of Middle and Late Jurassic age (referred to as the "Weary graywacke" by Hoare and others, 1975, p. 2-3) that underlies a large area in the southeast corner of the geologic map is best exposed at Kulukak Bay. The unit is also exposed on Hagemeister Island, and isolated patches of similar rocks form part of the KJvs volcanic and sedimentary rock unit as far north as the head of Togiak River. Consists of very hard graywacke and siltstone with local conglomerate. Beds generally thick or massive. Composition varies from quartz and plagioclase-rich wackes to quartz-poor volcanic wackes. Generally contains black argillite or tuff chips. Sparsely fossiliferous; contains Buchia, Inoceramus, belemnites, and rare ammonite fragments ranging from Middle Jurassic to early Late Jurassic age. Thickness unknown but probably 3,000 to 5,000 m or more

Jvs VOLCANIC AND SEDIMENTARY ROCKS--The southwest end of a large belt of interbedded volcanic and sedimentary rocks of Jurassic age is poorly exposed in a small area west of Great Ridge in the northwest quarter of the geologic map. Unit consists of andesitic, trachytic, and basaltic flows and breccias with interbedded fine- to coarse-grained sedimentary rocks. Fossils found in related rocks north of the geologic map area were originally assigned a Cretaceous age but were subsequently assigned a Middle Jurassic age (Hoare and Coonrad, 1959a, b). This unit is approximately coeval with the graywacke of Kulukak Bay (Jk) and the lower part of the KJvs volcanic and sedimentary rock unit

Jlvs VOLCANIC AND SEDIMENTARY ROCKS--Marine unit recognized only on Hagemeister Island and in the northeast corner of the map. On Hagemeister Island, unit consists of mafic flows, some with pillow structure, volcanic breccias, and massive fine- and medium-grained volcanogenic sedimentary rocks. Fractures commonly coated with laumontite. In the northeast corner, unit consists of impure sandy limestone. Early Jurassic age based on pelecypod Weyla (R. W. Imlay, written commun., 1952, 1976). Thickness unknown

Rvs VOLCANIC AND SEDIMENTARY ROCKS--Marine unit consisting of chert, tuffaceous cherty rocks, argillite, siltstone, volcanic wackes, conglomerate, limestone, and mafic flows and breccias. Sparsely fossiliferous; contains pelecypods of Late Triassic (Karnic and Noric) age (Mertie, 1938, p. 48; J. B. Reeside, Jr., written communs. 1950, 1951; P. R. Hoover, written commun., 1976; N. J. Silberling, written communs., 1976, 1977). Unit mapped only in vicinity of fossil localities because the rocks resemble other rocks of Paleozoic and Mesozoic ages with which they are tectonically associated. Thickness unknown

Pv VOLCANIC ROCKS--Unit consists of basalt flows, breccias, and a few sandy tuffs. Basalts are mostly amygdaloidal and mildly altered. Unit includes both columnar-jointed flows and pillow basalts interbedded with pillow breccias. Volcanic rocks grade downward into fossiliferous limestone of Permian age at Shadow Bay (Mertie, 1938, p. 45-46) in the northeast corner of the geologic map. Unit is coeval with some of the volcanic rocks in the undivided Mesozoic and Paleozoic rock unit (MzPz). Apparent thickness is 1,000 to 1,500 m, but shear zones and strong northwest-trending lineaments suggest that it probably is much thinner and duplicated by reverse faults

Pl LIMESTONE--Thin, widespread marine unit that probably includes several different limestone horizons of about the same age. Locally contains fossils of Permian age or is closely associated with rocks containing Permian fossils. Limestone is fine grained, commonly crystalline, light to dark gray, locally cream colored. Generally has strong fetid odor. Generally tuffaceous, locally cherty. Commonly closely associated with mafic volcanic rocks into which it grades through the medium of calcareous breccias and tuffs. Apparent thickness ranges from 5 to 10 m at some exposures to 150 to 200 m at other exposures

DOl LIMESTONE--Thin-bedded to massive, fine-grained gray limestone, highly fractured and veined with white calcite, contains algal reefs and reef breccias. Locally contains interbedded tuffs and mafic volcanic rocks. Recrystallized to marble with interbedded quartzite and quartz-chlorite schist in west part of geologic map. Contains sparse fossils of Early to Middle Devonian age (H. M. Duncan and J. M. Berdan, written commun., 1952; W. A. Oliver, Jr., written commun., 1977) and Early(?) Ordovician age (John Repetski, written commun., 1977). Thickness unknown but probably more than 300 m

MzPz MESOZOIC AND PALEOZOIC ROCKS UNDIVIDED--A thick, widespread, chiefly marine unit consisting of volcanic and sedimentary rocks ranging in age from Early(?) Ordovician to Early Cretaceous. Volcanic rocks include many pillow basalts, as well as breccias, crystal-lithic tuffs and flows of mafic and intermediate composition. Sedimentary rocks probably include both deep and shallow marine facies. They consist of thin-bedded to massive tuffaceous cherts and siltstones, argillite, graywacke, pebble-cobble conglomerate, and limestone. Pillow basalts and other volcanic rocks are commonly interbedded with tuffaceous cherts or other fine-grained volcanogenic rocks. Elsewhere they grade vertically into limestone which commonly contains Permian fossils. Most volcanic rocks are Permian in age but there are others of Triassic and probable Devonian ages

METAMORPHIC ROCKS

Pzmg METAGABBRO AND GREENSTONE--Massive, fine- to coarse-grained, locally pegmatitic, greenish rocks constitute Chagvan Mountain and underlie most of Cape Newenham. Probable dismembered altered ophiolite complex consisting of mafic flows, dikes, volcaniclastic rocks, and gabbro. Serpentinite masses occur in sheared rock along faults. Primary minerals largely replaced by clinozoisite, amphiboles, calcite, chlorite, pumpellyite, prehnite, calcite, epidote, sphene, and grossular garnet. The secondary minerals indicate greenschist facies metamorphism and calcium metasomatism. The Paleozoic(?) age assignment is tentative because similar less altered rocks of both Paleozoic and Mesozoic ages are present to the north and northeast in the undivided Mesozoic and Paleozoic rocks (MzPz)

Pzcs CALCAREOUS SCHISTS--Schistose calcareous siltstone, limestone, and greenish tuffaceous rocks. Exposed on Cape Newenham, west side of Cape Pierce, and in the Arolik River basin area southeast of Figure Four Mountain. Age assumed to be Permian or older. Thickness unknown

pCk METAMORPHIC ROCKS OF KANEKTOK RIVER REGION--A northeast-trending belt of gneiss and schist in the Kanektok River region in the northwestern part of the map consists of sedimentary, volcanic, and plutonic rocks metamorphosed in upper greenschist and lower amphibolite facies. Includes medium- to coarse-grained, massive, and well-foliated biotite-hornblende gneisses, garnetiferous amphibolites, quartz-mica schists, and marble. Precambrian age based upon character of the rocks and numerous K/Ar age determinations made on biotite and hornblende separates, some of which have indicated ages as old as about 2,500 m.y. (D. L. Turner, written commun., 1977)

pCl MARBLEIZED LIMESTONE--White, gray, and brownish, locally garnetiferous marbleized limestones have been locally differentiated within the metamorphic rock sequence. Generally associated with quartzose schists containing muscovite, chlorite, and amphibole

INTRUSIVE ROCKS

Tif FELSIC INTRUSIVE ROCKS--Light-colored, fine-grained, commonly porphyritic rocks consisting largely of quartz and feldspar and minor mafic minerals. Chiefly rhyolitic to dacitic dikes and sills generally less than 10 m thick. Only a few shown on the geologic map. In the horizontal or gently dipping sedimentary rocks of Summit Island (Ks), these rocks form three or more sheetlike intrusive masses, the largest of which underlies an area of 8 km^2 and is 50-100 m thick. A feeder dike and the flat floor of this body are exposed in the sea cliffs (sec. 19, T. 14 S., R. 64 W.). The K/Ar age of biotite from a nearby body is 13 ± 0.5 m.y. (table 1, locality B)

Tim MAFIC INTRUSIVE ROCKS--Dark-colored dikes and sills, generally less than 10 m thick, consisting of diabase, basalt, dioritic and gabbroic rocks. Very common in the sedimentary rocks of Summit Island (Ks) and locally numerous in the KJvs volcanic and sedimentary rocks unit. Only a few shown on geologic map. A relatively large (12 km^2) body of biotite diorite on the south end of Buchia Ridge (sec. 25, T. 12 S., R. 63 W.) is probably tabular shaped because it appears to overlie the sedimentary rocks and there is little or no thermal metamorphism. Age based on intrusive relations and K/Ar age, 64.6 + 2 m.y., of biotite from biotite-diabase dike (table 1, locality D)

Tn IGNEOUS ROCKS OF NAYORURUN RIVER AREA--Intrusive-extrusive complex consisting of dikes, sills, and genetically related tuffs and breccias. Chiefly fine-grained, quartz-rich porphyritic rocks. K/Ar age of biotite from small pluton(?) near center of complex, 60.7 ± 1.8 m.y. (table 1 locality C)

TKg GRANITIC ROCKS--Fine-, medium, and coarse-grained, light- to dark-gray, rarely pink plutonic rocks; chiefly quartz monzonite, granodiorite, and quartz diorite constituting stocks. K/Ar ages of biotite and hornblende from stocks range from 62.5 to 72.5 m.y. (table 1, localities E through N)

Jg GABBROIC ROCKS--Medium- to coarse-grained, locally pegmatitic intrusive rocks consisting of hornblende, clinopyroxene, and calcic plagioclase. Locally contain olivine. Commonly show compositional layering. Generally associated with ultramafic rocks. K/Ar age determinations on hornblende range from 159.3 to 186.9 m.y. (table 1, localities O, P, and Q)

Jum ULTRAMAFIC ROCKS--Serpentinite, serpentinized dunite and websterite. Constitute two or more intrusive bodies and numerous probable tectonic blocks in fault zones. Jurassic(?) age suggested by association with gabbroic rocks (Jg) of Jurassic age and K/Ar age determinations of 176.4 and 186.9 m.y. on amphiboles from intrusive contact zone adjacent to the ultramafic body forming Red Mountain (table 1, localities R and S)

Jt TRONDHJEMITE--Light-gray, medium-grained intrusive rock consisting of abundant quartz, plagioclase, and minor chlorite. Forms Tokomarik Mountain on Cape Newenham, crops out north side Mitlak Mountain (sec. 2, T. 9 S., R. 73 W.) and constitutes many large boulders underlain by serpentinite (sec. 18, T. 4 S., R. 66 W.). Jurassic(?) age inferred from association with ultramafic rocks (Jum) and gabbroic rocks (Jg)

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BACKGROUND INFORMATION RELATING TO THIS REPORT IS PUBLISHED AS U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 78-9 (AVAILABLE FROM THE SAME SOURCE AS THE MAP)

GEOLOGIC MAP OF THE GOODNEWS AND HAGEMEISTER ISLAND QUADRANGLES REGION

SOUTHWESTERN ALASKA

BY

J. M. HOARE AND W. L. COONRAD

1978